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Method for the production of a semi-finished product for a wing-shaped element

The invention relates to a method for the production of a semi-finished product for a wing-shaped element and of the wing-shaped element itself. Such wing-shaped elements  
5 are found in many different embodiments. A so-called vane, which is fixed to a flap of an aircraft wing, is mentioned as an example.

Various production methods for such wing-shaped elements are known. Extrusion of the element is mentioned first. In such a case the element does not have to be made up of separate components, which is quick and relatively inexpensive. The disadvantage,  
10 however, is that the dimensional tolerance is poor. This arises, in particular, in the case of relatively small thicknesses. According to a further known method the element is produced from sheet material. After pre-forming the sheet material, this is stretched on a stretcher leveller for making sections that has a bottom block and top block. A mandrel is incorporated in the pre-formed sheet material. The whole is clamped at the longitudinal  
15 ends and then stretched. The disadvantage of this known method is that the surface obtained has irregularities.

The aim of the invention is to provide a method for the production of a semi-finished product for a wing-shaped element that does not have these disadvantages. Said aim is achieved by means of a method for the production of a semi-finished product for a wing-  
20 shaped element having, in cross-section, a front edge, a rear edge and an arched bottom wall and an arched top wall that extend some distance apart between the front edge and the rear edge, comprising the following steps:

- providing a metal sheet,
- bending the sheet with the formation of two panels as well as a curved region which  
25 the panels adjoin,
- providing a former, the exterior of which has the shape of the internal surface of the finished section,
- placing the former in the bent sheet with the front edge of the former positioned in the curved region,
- providing an edge press provided with a pressure member and a rubber cushion located opposite,
- fixing the former to the pressure member,

- forcing the pressure member towards the rubber cushion with the bent sheet enclosed between them and deforming said sheet between the former and the rubber cushion,

- removing the former with shaped sheet from the edge press,
- 5 - placing these in a rubber press provided with a bottom block having a cavity which has a shape that at least approximately corresponds to the external shape of one of the walls of the shaped sheet,
- pressing the shaped sheet with former between the bottom block and a rubber mat,
- removing the semi-finished product from the rubber press.

10 With the method according to the invention the semi-finished product is shaped by exerting pressing forces thereon via rubber elements. In combination with the former acting as a mandrel that has the correct contour, an extremely accurate shape is obtained by this means which has a surface that has the smoothness desired for aircraft for aerodynamic reasons.

15 The two panels are preferably arched after, or before, or at the same time as bending the sheet. The arching can be oriented in the same direction in order to obtain a relatively strong curved element. However, the archings can also be oriented away from one another.

Bending and optionally arching the panels can be effected by means of roller forming or by means of rolling. The rear edge of the element can be made as a section that is fixed  
20 to the top wall and the bottom wall. Furthermore, the wing-shaped element can be subjected to a heat treatment, for example stress-free annealing or solution annealing.

The invention also relates to a wing-shaped element produced in accordance with the method according to the method described above, which element, for example, can be made as a vane.

25 Reference is made to the wing-shaped element that is disclosed in US-A 4 531 270. This element is produced from a relatively flat section that comprises two panels that form a whole and in which the arching of the ultimate walls has been pre-produced by a locally greater material thickness. The element is obtained from this by simply folding the panels onto one another, after which the element is ready. The element concerned here is in the  
30 form of a blade for turbines.

The invention will be explained in more detail below with reference to an illustrative embodiment shown in the figures.

Fig. 1 shows a curved and arched sheet that serves as starting material for the method according to the invention.

Fig. 2 shows the element in an edge press.

Fig. 3 shows the result after performing a treatment in the edge press.

5 Fig. 4 shows a perspective view of the rubber press block of a rubber press, with the mandrel.

Fig. 5 shows the product obtained after rubber pressing.

Fig. 6 shows the finished wing-shaped element.

When carrying out the method according to the invention the starting material used is  
10 the bent sheet 1 shown in Fig. 1, which has been bent with the formation of a bent front edge 2, a concave arched panel 3 and a convex arched panel 4. This bent sheet 1 is placed in the edge press 5 shown in Fig. 2, which has a base 6 with rubber cushion 7 as well as a pressing member 8 that can be moved up and down and to which the former 10 is fixed by means of the supports 9. This former 10 or mandrel 10 is also shown in a perspective view  
15 in Fig. 4. It has the shape of the internal surface of the finished wing-shaped element, that is to say with a front edge, rear edge and arched top surface and bottom surface. The former can have a prismatic shape but also a twisted shape.

When pressing the bent sheet 1 in the edge press, the front edge of the former 10 is pushed into the curved region 2 of the sheet 1. By this means this curved region is curved  
20 more severely around the front edge of the former 10, under the influence of the even inward pressure by the rubber cushion 7. As a consequence of this, the arched panels 3 and 4 come closer together, as shown in Fig. 3.

The sheet 1 further shaped in this way is then placed in a rubber press, the rubber press block 11 of which can be seen in Fig. 4, the interior shape of which corresponds to  
25 the front edge and an arched surface of the wing-shaped element. Together with mandrel 10, the sheet 1, which now has the shape as shown in Fig. 3, is placed in this rubber press block 11. The rubber mat 12 is then placed on top of the whole of this, after which the sheet 1 with the mandrel 10 therein is compressed between the rubber press block 11 and the rubber mat 12 by a press (not shown).

30 After rubber pressing, the semi-finished product 13 shown in Fig. 5 is obtained, which has a curved front edge 2, a convex arched top surface 2 and a concave arched bottom surface 3. Finally, the section indicated in its entirety by 14 is fixed to the rear, free ends of the walls 2, 3. For this purpose the section has a body 15 with sides 16, 17 tapering

down with respect to one another that are oriented in accordance with the run of the top wall 2 and the bottom wall 3. The section 14 is fixed to the semi-finished product 13 by means of rivets 18 driven through the top wall 2, the body 15 and the bottom wall 3, after which the wing-shaped element 15 is ready. As an alternative, the walls 2, 3 can also be  
5 fixed directly to one another, such as by bonding, riveting and the like.